

Claims

[c1] What is claimed is:

1. An antenna, comprising:

a dielectric layer having a first surface and a second surface which is spaced apart from and is substantially parallel to the first surface;

a ground layer of electrically conductive material covering a portion of the first surface of the dielectric layer;

a feed-line of electrically conductive material disposed on the second surface of the dielectric layer;

a first radiating element of electrically conductive material electrically coupled to the feed-line, wherein the first radiating element is for generating a first and a third operating frequency of the antenna;

a tuning element of electrically conductive material electrically coupled to the first radiating element and disposed on the second surface for adjusting the overall length of the first radiating element, wherein the tuning element comprises at least two stubs, each stub having a fixed end coupled to the first radiating element and a free end spaced apart from each other; and

a second radiating element of electrically conductive material electrically coupled to the feed-line and disposed

on the second surface, wherein the second radiating element is for generating a second operating frequency of the antenna.

- [c2] 2.The antenna of claim 1 wherein the first radiating element in combination with the tuning element forms a length of about one-quarter wavelength of the first operating frequency.
- [c3] 3.The antenna of claim 1 wherein the second radiating element forms a length of about one-quarter wavelength of the second operating frequency.
- [c4] 4.The antenna of claim 1 wherein the first radiating element in combination with the tuning element forms a length of about three-quarters wavelength of the third operating frequency.
- [c5] 5. The antenna of claim 1 wherein the second and the third operating frequency are proximal to effectively from a first operating frequency band of the antenna.
- [c6] 6. The multiple-frequency antenna of claim 1 wherein the first operating frequency corresponds to a second frequency band of the antenna.
- [c7] 7. The multiple-frequency antenna of claim 1 wherein the stubs of the tuning element are parallel to each

other.

[c8] 8.The multiple-frequency antenna of claim 7 wherein the stubs of the tuning element and the first radiating element form a substantially claw-of-crab-shaped structure.

[c9] 9.The multiple-frequency antenna of claim 1 further comprising an impedance matching portion electrically coupled to the first and second radiating elements for matching the impedance of the antenna.

[c10] 10.An antenna, comprising:
a first radiating element having an overall length of L_1 ;
a tuning element electrically coupled to one end of the first radiating element, the tuning element comprising at least two stubs, each stub having a free end spaced apart from each other and having an overall length of L_2 , wherein the first radiating element and the tuning element are for generating a first and a third operating frequency of the antenna; and
a second radiating element electrically coupled to one end of the first radiating element, wherein the second radiating element has an overall length of L_3 for generating a second operating frequency of the antenna;
wherein the first radiating element and the tuning element form a substantially claw-of-crab-shaped struc-

ture.

- [c11] 11.The antenna of claim 10 further comprising:
a printed circuit board of dielectric material having a first surface and a second surface which is spaced apart from and is substantially parallel to the first surface;
a ground layer of electrically conductive material covering a portion of the first surface of the printed circuit board; and
a feed-line of electrically conductive material electrically coupled to the first and second radiating elements and disposed on the second surface of the printed circuit board;
wherein the first radiating element, the tuning element, and the second radiating element are both made of electrically conductive material and disposed on the second surface of the printed circuit board.
- [c12] 12.The multiple-frequency antenna of claim 10 wherein $L1+L2$ is about one-quarter wavelength of the first operating frequency.
- [c13] 13.The multiple-frequency antenna of claim 10 wherein $L3$ is about one-quarter wavelength of the second operating frequency.
- [c14] 14.The multiple-frequency antenna of claim 10 wherein

L1+L2 is about three-quarters wavelength of the third operating frequency.

[c15] 15. The antenna of claim 10 wherein the second and the third operating frequency are proximal to effectively from a first operating frequency band of the antenna.

[c16] 16. The multiple-frequency antenna of claim 10 wherein the first operating frequency corresponds to a second frequency band of the antenna.

[c17] 17. The multiple-frequency antenna of claim 10 wherein the stubs of the tuning element are parallel to each other.

[c18] 18. The multiple-frequency antenna of claim 10 further comprising an impedance matching portion electrically connected to the first and second radiating elements for matching the impedance of the multiple-frequency antenna and improving transmission and reception characteristics of the multiple-frequency antenna.